ABSTRACT

CiRCLETECH

The development of a European Sustainable Circular Economy Research Hub

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Circular Economy; Horizon Europe; Research Hub; University cooperation

CiRCLETECH project will be raising the scientific excellence of the cooperating partners, University of Miskolc in Hungary, Delft University of Technology in Netherlands and LUT University in Finland. The aim is to create a Research Hub on Sustainable Circular Economy across Northern Hungary. CiRCLETECH will provide the basis of future cooperation and operation of a regional excellence center, creating meaningful impact on regional and national level on circular economy, but also on involvement in Horizon Europe.

Funded by the European Union

ABSTRACT

Pressure-driven filtration for the separation of battery metals

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Keywords Continuous diafiltration; Nanofiltration membrane; Lithium; Cobalt; Separation Factor.

The development of efficient recycling processes for lithium battery waste material is very important from the point of view of sustainable economy. Pressure-driven membrane filtration experiments were conducted using the large scale commercial diafiltration DSS Labstak M20 membrane test unit (Alfa Laval). Approx. 10 L of synthetic leachate solution, having the following concentrations of metals: 1.4 g/L Al, 16 g/L Co, 2.0 g/L Cu, 0.7 g/L Fe, 2.5 g/L Li, 2.0 g/L of Mn and 1.9 g/L Ni, was prepared from sulphate salts of metals. Nanofiltration membrane Desal KH from GE Osmonics was used. The filtration experiment was designed to have two steps: continuous diafiltration with addition of acidic water (pH of 1.5), which is followed by concentration step. During the first step, the permeate flux remains in the range 30-35 L/ (h m^2); by the end of this step 5.9-fold dilution has been reached. Diafiltration removes monovalent ions such as Li from the multivalent ions. In the concentration step 3.8 volume reduction factor has been reached. Figure 1 shows the results of separation between Li and Co. The separation factor of 250 was achieved at the end of the concentration step.

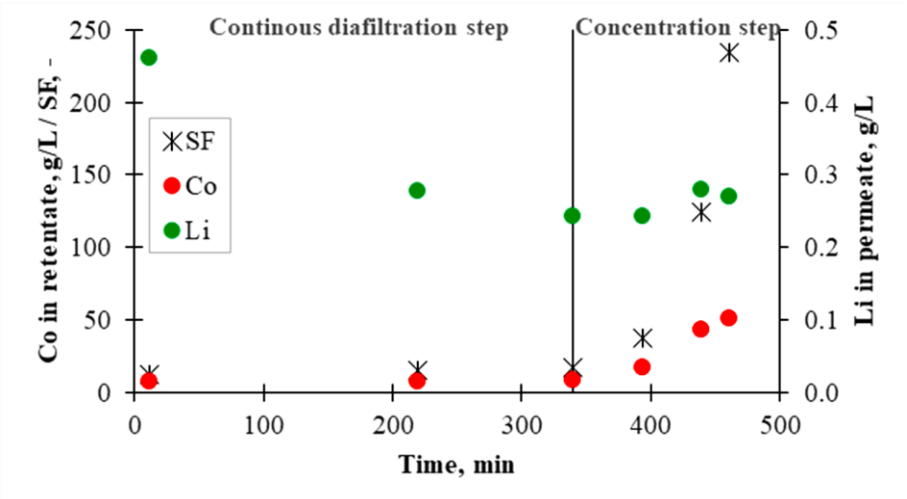

Figure 1. Concentration of Co in retentate and Li in permeate, and separation factor during diafiltration and concentration steps.

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Mining and Minerals amid Geopolitics and Energy Transition

ABSTRACT

EFFECT OF ANDESITE PROPERTIES ON BREAKAGE BEHAVIOUR

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andesite; geological properties; breakage, single particle breakage test

The demand for construction aggregates has been increasing in the last decades, most construction aggregates still come from primary natural resources. Andesite is one of the most commonly used raw material in aggregate production. The decreasing availability of good quality resources, the fluctuation in raw material quality within one production sites and the energy consideration of comminution processes makes unavoidable the optimization of comminution processes. The detailed knowledge of factors influencing the breakage process and the product properties are of key importance for the optimalization of the comminution process. Different methods exist for assessing the energy requirements of comminution processes, choosing the adequate testing method and obtaining the adequate result can be crucial. The influence of material properties, especially the geological properties and cracks, porosity, particle shape and size of the raw material are known from the literature to have significant influence on the breakage properties. A systematic study has been conducted on andesites originating from a quarry in NE-Hungary, representing andesite samples with different quality based on their alteration. The geological properties were quantified, through the quantitative determination of mineralogical composition, micro-textural observation and quantification, calculation of alteration indexes and determination of porosity. Single particle breakage test in the form of drop weight testing, and grindability test were conducted. Results highlighted that rocks with similar quantitative mineralogical compositions show different breakage properties in the case of drop weight testing, leading to the conclusion that the effect of mineralogical composition, texture parameters and porosity exert their effect simultaneously, leading to complex breakage behaviours. The influence of the parameters shifts with the decrease of particle size, the texture parameters become more significant. The grindability test resulted in different outcome, leading to the conclusion that the factors influence the process in a different manner.

ABSTRACT

Mechanical Activation of Glass Waste from Monocrystalline Solar Panels for Enhanced Cementitious Applications

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Keywords: Mechanical Activation; Glass Waste; Monocrystalline Solar Panels; Cementitious Applications; Sustainability

The rapid growth of the solar energy industry has led to an increased generation of waste, particularly from decommissioned monocrystalline solar panels. The disposal of these panels poses significant environmental challenges due to the non-biodegradable nature of their components, primarily the glass. This study explores the mechanical activation of glass waste recovered from monocrystalline solar panels and its subsequent utilization in cementitious applications, aiming to enhance sustainability in the construction industry (Dias et al., 2016). Mechanical activation involves the grinding of glass waste to increase its surface area and reactivity. This process transforms the inert glass into a highly reactive pozzolanic material, which can be used as a supplementary cementitious material (SCM) (Yoon, 2005). This study highlights the potential of using mechanically activated glass waste from monocrystalline solar panels in cementitious applications, offering a sustainable solution to the dual problems of solar panel waste management and resource consumption in the construction industry. Integrating this waste material contributes to reducing landfill disposal and promotes the circular economy by converting waste into valuable construction materials. Future research should focus on long-term performance evaluations and the feasibility of large-scale implementation. By transforming solar panel glass waste into a functional SCM, this research paves the way for innovative and eco-friendly construction practices, aligning with global sustainability goals. The first step entailed the manual removal of the aluminum frame. Subsequently, a rotary disc shredder was employed to crush the solar panels. Following this, sieve analyses were performed on the resulting material using multiple sieves. The grinding process was subsequently applied only to the fraction size below 4mm, which constituted 26.45% of the total mass, equivalent to 7.125 kg. A representative sample from this fraction was ground using a planetary mill for mechanical activation. The ratio of steel balls to the feed of waste glass was maintained at 4:1. The residence times of the glass in the mill were set at 3, 5, 10, 15, 30, 60, and 120 minutes. Figure 1 illustrates the particle size distribution curves corresponding to the various milling durations.

ABSTRACT

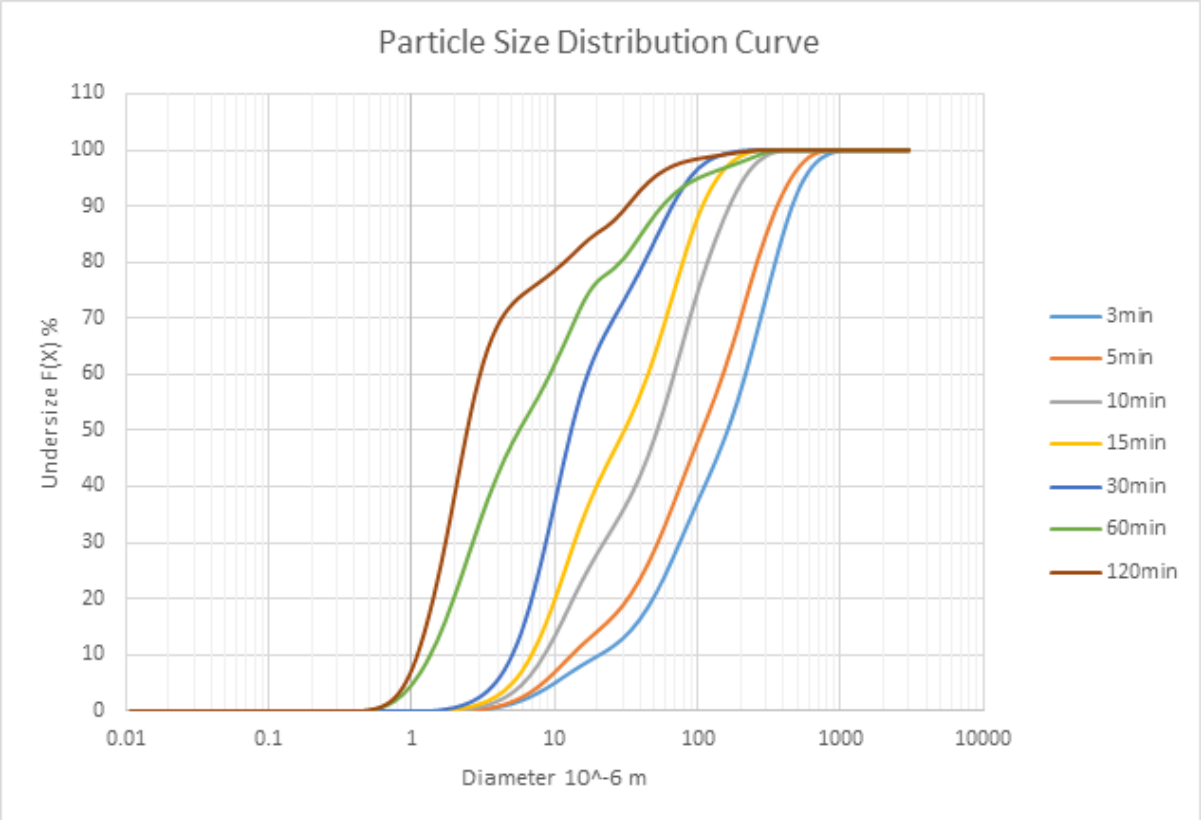

Figure 1. Particle size distribution for different glass waste milling times.

References:

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Xplorer Conference 11-12, 2024
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ABSTRACT

How logistics optimization supports green universities:
facility location in selective waste collection at the University of Miskolc

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green management; sustainability; waste collection; multi-facility location search; optimization

Effective waste collection systems, particularly in selective collection, is crucial for sustainable development and environmental conservation. Many individuals and institutions fail to implement proper waste segregation, leading to increased pollution and resource depletion. The University of Miskolc faces this challenge, with inadequate systems for selective waste bin installation and collection. Recognizing the need for change, we conducted a comprehensive examination of the university's facilities. Our findings revealed a lack of systematic approaches to waste management, with only low efforts from the management at this task. To address this issue, we developed an algorithm designed to optimize the placement of waste bins across the campus. This task involves solving a Facility Location Selection (FLS) problem with constraints that can be modeled as a graph, specifically a line task. By reducing the problem to a graph representation, we created an algorithm capable of determining the most efficient locations for waste bins. As a case study, we applied our algorithm to the entire University of Miskolc campus, strategically placing collection centers to maximize accessibility and efficiency. This optimal placement not only facilitates better waste segregation practices but also encourages the university community to participate in sustainable waste management actively.

Xplorer Conference 11-12, 2024
Mining and Minerals amid Geopolitics and Energy Transition

ABSTRACT

WASTE MANAGEMENT IN THE INDUSTRY 4.0 ERA: AN OPTIMIZATION-BASED APPROACH

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waste management; collection system; routing; scheduling; optimization

Waste collection and recycling processes have represented a special sector of the economy, which harnesses modern technology to improve availability, flexibility, efficiency and productivity. The ever-changing structure of municipal waste collection systems requires the improvement of these attributes. Statistical surveys show that by the end of 2023, about 70% of large service companies will update their operations with Internet of Things solutions and transform their conventional service processes into cyber-physical systems. The integration of Internet of Things solutions can result hyper-connected value chains. Within the frame of this research, the potential application of Industry 4.0 technologies in waste collection solutions in downtown area are described. The highlights of the research can be summarized as follows: (1) mathematical model of cyber-physical waste collection process integrating routing, assignment, and scheduling problems; (2) increased cost-efficiency and decreased environmental impact; (3) scenario analysis: in downtown of Budapest. The added value of the research is the description of the mathematical model of the traditional and cyber-physical waste management system, which makes the description of the impact of Industry 4.0 technologies, like RFID, cloud and fog computing, big data analysis when developing and operating them possible. The results can be generalized, because the model can be applied for different fields of waste management systems from the wastes of electrical and electronic equipment (WEEE) to biomass or medical waste.

ABSTRACT

WEAKPOINTS OF CIRCULAR MANUFACTURING

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Keywords: Thermoelectric Systems; Circular Manufacturing; Lifecycle Cost Analysis;

Environmental Impact

In recent decades, interest in clean and renewable energy sources has significantly increased in response to pollution caused by traditional energy sources. Circular manufacturing, as a sustainable production model, aims to minimize waste and make more efficient use of resources. In this study, we perform a lifecycle cost analysis. In the context of circular production systems, TE modules offer a sustainable and cost-effective solution that can contribute to minimizing waste and more efficiently using resources.

ABSTRACT

Using AGV and AMR in Circular Economy

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Keywords: AGV, AMR, logistics, circular economy

Automated Guided Vehicles (AGVs) and Autonomous Mobile Robots (AMRs) are revolutionizing the circular economy by enhancing efficiency, reducing waste, and promoting sustainability. The circular economy focuses on minimizing waste and maximizing resource utilization through recycling, reuse, and sustainable manufacturing processes. AGVs and AMRs contribute significantly to these objectives.

Efficiency and Waste Reduction: AGVs and AMRs are key elements in an automated material handling and transportation system within facilities, reducing human error and operational inefficiencies, ensuring that materials are moved precisely where needed, thus minimizing waste. By improving the accuracy and speed of logistics, these technologies reduce the overproduction and unnecessary inventory that often produce unnecessary waste.

Recycling and Reuse: In recycling facilities, AGVs and AMRs can be programmed to sort and transport recyclable materials, ensuring a more efficient recycling process. Their ability to operate in harsh and hazardous environments makes them ideal for handling waste that would be dangerous for human workers. This automation increases the throughput of recycling operations and enhances the quality of sorted materials, making them more suitable for reuse in manufacturing.

Sustainable Manufacturing: AGVs and AMRs support sustainable manufacturing by enabling just-in-time production, which reduces the need for large inventories and lowers the risk of obsolete stock. This approach aligns with the principles of the circular economy by ensuring that resources are used only when necessary and in precise amounts.

Future Prospects: As technology advances, AGVs and AMRs are expected to become even more integral to the circular economy. Innovations such as improved battery life, advanced sensors, and better AI will enhance their capabilities, making them more efficient and adaptable to various tasks within the circular economy framework.

In conclusion, AGVs and AMRs are crucial in advancing the circular economy by improving operational efficiency, reducing waste, and promoting the recycling and reuse of materials, thereby boosting a more sustainable industrial ecosystem.

ABSTRACT

DESIGN FOR CIRCULAR MANUFACTURING

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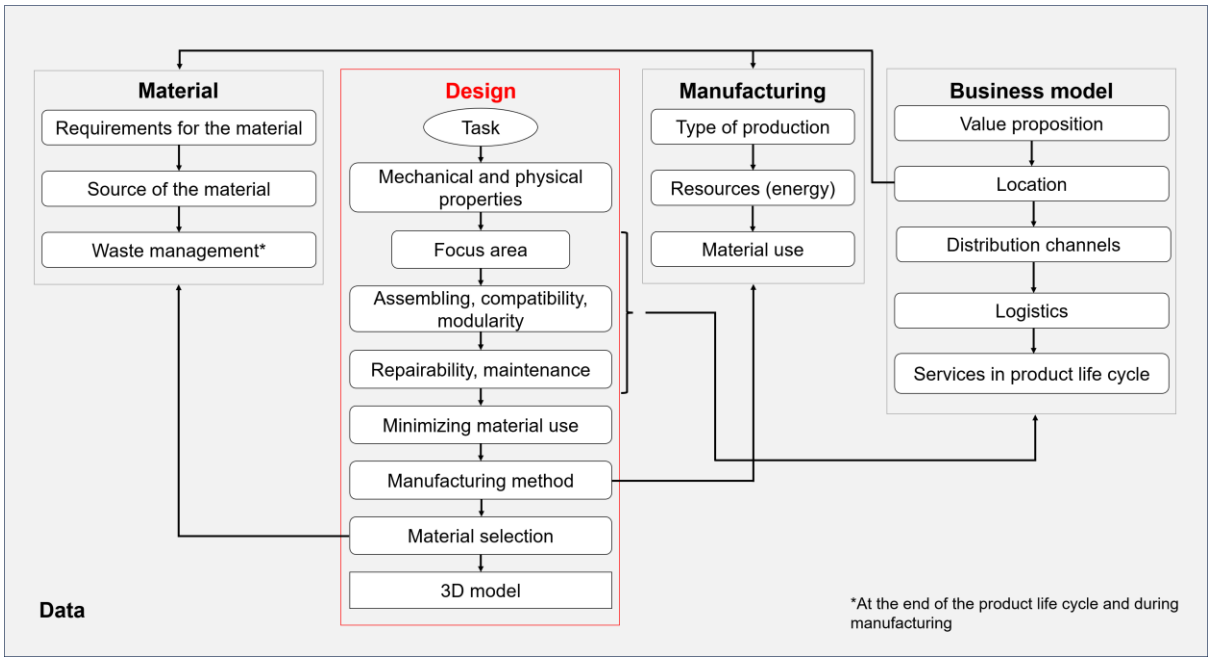
product design, circular economy, manufacturing, design method

Most of the problems to be solved nowadays are related to climate change and environmental protection. Sustainability and encouraging the transition from a linear economy to a circular economy are among the main directives in the creation of European Union regulations. The circular economy is a system-based model in which the lifetime of products is extended as much as possible and the loss of value is reduced by circulating resources in a closed loop. Design plays a significant role in the circular economy, as decisions made in this phase are responsible for more than 80% of a product's impact on the environment.



Our aim was to develop a complex yet transparent and easily applicable design method that covers all aspects of the circular economy. The proposed method focuses on a process-based approach, the

ABSTRACT

design process, and the effect of decisions made at each step. The main module, the design process, is influenced by three smaller decision modules: material, manufacturing, and business model. As indicated by the arrows in the figure, these modules are not only related to the design but also to each other. In each of the decisions made in the individual sub-parts and elements of the process, alignment with the circular economy and the impact of the modules on each other must be kept in mind. These steps are carried out iteratively with continuous feedback and improvement.

ABSTRACT

The Circular Battery Value Chain: A Value Chain mapping approach

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Keywords max (5 separated by semicolons): Circular Value Chains; Lithium-Ion Batteries; Second life; Circular Economy,

EU's efforts on promoting circularity have not led to concrete systemic implications in reuse of endof-life (EOL) lithium-ion batteries (LIBs). The trend of electrification has created a demand for various battery applications, which has significantly influenced scarce mineral availability for battery manufacturing. To secure crucial battery minerals, the development of effective recycling processes for EOL LIBs has been emphasized over reuse. Furthermore, the process of recycling EOL LIBS more conveniently fits into the existing linear value chains, compared to developing second and third life applications. This is also highlighted in the New Battery Regulation (2020/0353) where focus is heavily on recycling targets, use of secondary minerals, efficiency in recycling processes, and battery passport and traceability, whereas there are no concrete goals defined for second and third life use. Because focus is on recycling, the potential value of EOL LIBs remaining capacity (70 -80%) through reuse is lost.

LIBS are a strategic focus of the EU and there is a common consensus on the need to minimize dependency of battery minerals and technologies with China. Due to the rapid electrification of transportation, the amount of EOL LIBS will grow exponentially in the future. The EU will need to have a clear understanding of its battery value chain capabilities to level out the playing field and create a viable circular battery value chain within the EU.

We will map and define the European Circular Battery Value Chain. This will include an in-depth analysis of factors influencing the value chain, key barriers and drivers and incentives and government initiatives for circularity. In addition, stakeholder interactions including but not limited to material, information and logistics flows will be identified.

This research is part of the European Union Horizon Europe Research and Innovation Programme funded REINFORCE -project (Grant Agreement No. 101104204).

ABSTRACT

Exploitation pathways of recycling Lithium from secondary sources: a sustainable transition

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Keywords: Exploitation; lithium; recycling; sustainability; critical raw materials

Lithium (Li) has become one of the key raw materials in strategic EU sectors such as energy storage and mobility. Mitigating supply risks is therefore critical to achieving the EU's Green Deal plan. However, the extraction, use and recycling of Li raises new environmental, economic, political and societal concerns in planning for a sustainable future.

This study builds on the exploitation pathways of the EU-funded project RELiEF (www.lithium-relief.eu) and provides an overview of the work carried out and the potential use of the results generated. It also highlights the importance of clustering with other Horizon Europe projects to develop synergies by showing how RELiEF has benefited from sharing knowledge, experience, and best practice through activities such as workshops and conferences within the Materials for Batteries cluster hub.

The study discusses the following four aspects:

1. The environmental dimension – exploiting newly developed processes while ensuring environmentally friendly extraction and recycling of Li.
2. The economic dimension - ensuring economic benefits from Li recycling at local, regional, national and European level.
3. The political dimension – demonstrating how the exploitation of new results must meet the requirements of EU funding bodies and external stakeholders such as policy makers in order to make the ideas a success.
4. Finally, the societal dimension - to provide further reflections on how the involvement of all stakeholders in Li recycling can work for the benefit of European citizens.

ABSTRACT

Master in Sustainable Mineral and Metal Processing Engineering - EMJM PROMISE at the University of Oulu

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Keywords: Education, Mineral Processing, Mineral and Metals, Engineering

PROMISE is a two-year Erasmus Mundus Joint Master Degree Program focused on “training future leaders to take mineral and metal processing engineering into a sustainable future”. The consortium is coordinated by University of Oulu (Finland) and participation of the Montantuniversität Leoben (Austria), University of Zagreb (Croatia) and Universidad Tecnica Federico Sant Maria (Chile).

The program is built on the strengths and the complementary areas of expertise of the four partner universities in recovery and extraction of minerals and metals, such as comminution, metallic and industrial minerals physicochemical processing, wet and dry processes, mineral and metal recycling and circular economy. Their involvement in a single program enables integration of the whole chain of mineral processing required for the mining industry.

The presented program reflects the future demands of mining and mineral processing engineering, the needs of the industry, disruptive innovation and mobility (triggered by key economic, incremental and societal trends), and required competences and knowledge that a mineral processing engineer should have to cope with those challenges.

To provide real-life context for the lectures, the consortium currently also comprises 35 associated partners (APs), like mining companies, equipment manufacturers, research centers, or further universities (Table 1). They contribute mainly by bringing up the topics and environments for doing the master’s theses and providing students with internships.

In line with the international character of an EMJM, PROMISE accepts students from all over the world, following the principles of diversity and inclusion. Mobility is a must to partners HEIs.

Xplorer Conference 11-12, 2024
Mining and Minerals amid Geopolitics and Energy Transition

ABSTRACT

Social impacts of lithium mining from industrial side-streams – A life cycle perspective

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Lithium recycling; Side streams; Social impacts; Social life cycle assessment

Green transition has increased the demand for certain minerals that are needed in e.g., electric vehicle (EV) batteries. However, mining these materials may cause negative social impacts especially in global south but also social acceptability issues in global north. Recycling of these materials has a potential to reduce the negative social impacts. The demand for the EV battery materials e.g., lithium has been estimated to increase so much that all the available sources should be explored. One of these sources are industrial side-streams e.g., mine tailings or different manufacturing industries. The aim of this study is to investigate the social impacts of lithium recycling from two different side-streams using social life cycle assessment (S-LCA).

S-LCA can be used to study the positive and negative social impacts of products or product systems. Assessing the whole life cycle prevents the shifting of impacts from one life cycle phase to another. In this study, the social impacts are assessed from the perspective of different stakeholders: local communities, value chain actors and society. The system boundary includes life cycle stages from side-stream to battery material production. A suitable set of indicators for the case study has been developed and the data will be collected from companies by using a questionnaire and interviews. The final S-LCA results will be calculated by formulating a reference scale defining the social performance of the lithium recycling system. The relative importance of different social impacts in the lithium recycling context will be also assessed.

The results will be used for the development of a sustainable lithium recycling value chain as part of the RELIEF project. This study further contributes to the progress of S-LCA in the context of EV battery materials.

ABSTRACT

News media representations of the battery cluster plans in Vaasa and Kotka-Hamina regions

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Keywords: media representations, policy instruments, battery production

Finland is aiming for carbon-neutrality by 2035, and electrification, which requires large-scale battery production, is one pathway towards this goal. Finland's National Battery Strategy sets out actions for Finland to become a significant player in the sustainable battery sector by forming a Finnish battery value chain. This poster focuses on two regional endeavours in Kotka-Hamina and Vaasa regions as examples of the Finnish strategy.

This poster focuses on news media because media forms a bridge between science, policy, and the public. Mass media makes certain issues known to the larger public and can thus effect public perceptions. The newspaper articles were collected from Yle (Kotka-Hamina N=102, Vaasa N=102) and Helsingin Sanomat (Kotka-Hamina N=34, Vaasa N=8) websites from 2020 to 2024. The data was coded in Atlas.ti with a focus on actors and policy instruments to see which actors ware talking about which policy instruments, how they were talking about them and if alternatives to existing policies were offered.

Understanding media representations can shed light on how public perceptions are formed and how this might affect the industrial development. Preliminary results indicate that industry actors and non-governmental organizations had differing views on the impacts of the planned factories, the former calling for better technology or compensations to reduce the possible negative environmental effects. Calls were also made to curb the state-aid competition within the European Union as Finland and other smaller countries would not be able to compete for investments with larger European countries.